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ELECTROLUMINESCENT CELL HAVING ELECTRICAL CONTACT WITH INCREASED RELIABILITY

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This invention relates to pressure and spring type electrical contacts encapsulated in plastic. Particularly, this invention concerns encapsulated electroluminescent devices having spring or pressure type electrical contacts of increased reliability.

Encapsulated electrical contacts are known to the art and methods have previously been devised for their fabrication. Examples of devices using these encapsulated contacts are described in the copending applications of George H. Bouchard, Serial Number 51,554 filed August 8, 1960 entitled Electroluminescent Device and Robert S. Bowser et al. Serial Number 130,661, filed August 10, 1961, entitled Electroluminescent Device, each of which is assigned to the assignee of the instant application.

Certain problems have arisen in electroluminescent devices encapsulated in plastic when pressure or spring type electrical contacts are used for conducting current to a film of metal oxide which serves as an electrode of the device. Often such contacts tend to loosen when subjected to vibration or shock, thus breaking the circuit and rendering the device inoperative. Also, as the plastic ages it will pull the contact away from the contact surface. Because of the possibility of heat damage to the metal oxide, the above-mentioned types of electrical contacts cannot be welded or soldered thereto. Another difficulty with such contacts is produced by encapsulation media. Particularly when encapsulating with epoxies, which have a tendency to wet very close surfaces, these materials will coat and insulate the contacts from each other. Of course, after such coating and insulation, the electrical circuit will be broken, even if the contact is quite close. Often the defect cannot be detected until after the resin has hardened and thus the electroluminescent device is useless; reworking cannot be economically effected.

To eliminate these problems and difficulties, we have formulated a so-called "conductive grease" which we prepare by milling a suitable finely divided electrically conductive material such as carbon, aluminum, gold, silver, platinum, copper, iron or nickel into a compatible polymer which generally is the same polymer as the encapsulation media. We may use 10% to 50% by weight electrically conducting material in the mixture and no catalysts are added so that the grease will always remain fluid.

After milling, a small portion of the conductive grease is applied to the base contact point and the spring or pressure contact is forced upon this coated base. The device is then ready for encapsulation in plastic according to conventional techniques. The encapsulation media will harden and surround the still-fluid grease. When using an epoxy resin for the dispersing media of the grease and an epoxy containing a catalyst for the encapsulation media, the outer surface of the conductive grease hardens and prevents the encapsulation media from creeping between the contacts. Thus, insulating encapsulation media cannot effectively penetrate and break the circuit.

Accordingly, the primary object of this invention is the assurance of reliable electrical connections with pres-

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sure or spring type electrical contacts encapsulated in plastic.

Another object of our invention is the assurance of reliable electrical connections with pressure or spring type electrical contacts used in encapsulated electroluminescent devices.

A feature of this invention is the use of a finely divided, electrically conductive material dispersed in polymer to form an electrically conductive grease of heavy viscosity.

Another feature of this invention is that the conductive grease remains in a viscous but fluid state when disposed between the electrical contacts.

An advantage of this invention is that a positive and reliable electrical connection is always afforded in an encapsulated electrical device.

The many other objects, features and advantages of the instant invention will become manifest to those versed in the art upon reading the following specification, when taken in conjunction with the accompanying drawings, wherein a specific embodiment of this invention is shown and described by way of illustrative example.

Referring to the figure, a cross section of an encapsulated electroluminescent device is shown together with pressure type and spring type electrical contacts.

Describing now the structure of the electroluminescent device, base electrode 1 is preferably prepared of a metal plate, since such a material imparts stability, however it is apparent that many other materials also can be used. For example, the base electrode 1 may be prepared of a metal foil or of other material, such as glass which has been rendered electrically conductive. In these latter examples, the device has the added features that it may have two light emitting faces or may be flexible.

When desired, a ground coat layer 3 prepared of a layer of low melting, ceramic dielectric material of known and suitable composition is coated over the base electrode 1 to provide a bonding surface for light producing layer 5. It has been found that when using a metal plate for the base electrode 1, permanent adherence of the glass dielectric, light producing layer is rather difficult to establish, unless a ground coat is used. However, the ground coat may be omitted if the light producing layer readily adheres to base electrode 1, such as would be the case if the electrode is electrically conductive glass.

Superposed upon the ground coat 3 or on the base electrode 1, as desired, is a light-emitting layer 5 which is generally prepared of an electroluminescent phosphor suspended in a light-transmitting dielectric material. The electroluminescent phosphor may be for example a copper activated zinc sulfide such as described in the copending application of Goldberg et al. entitled Electroluminescent Device, Serial No. 714,484 filed February 11, 1958. The light-transmitting dielectric may be for example a glass frit such as described in the application of Richard M. Rulon, Serial No. 365,617 filed July 2, 1953.

Adhering to the light-emitting layer 5 is a coating which forms a light-transmitting electrode 7. This coating may be applied by spraying the light-emitting layer 5 with a solution of metal compounds, for example chlorides, oxides, sulfates or organic complexes of tin, antimony or indium; however other available methods of applying an electrically conductive coating are for example, dipping or vapor deposition of metals. If the light-emitting layer 5 is hot when the solution of metal compounds is applied, a metal oxide of the metal compound will be formed, however other methods may also be devised for formation of the metal oxide layer.

After the application of the light-transmitting electrode 7 on the face of the light-emitting layer 5, it is good